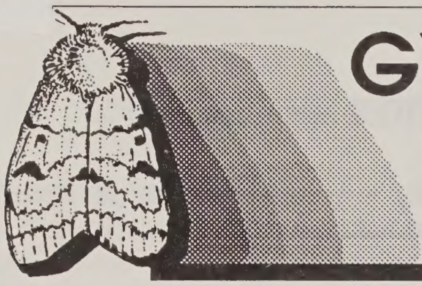

# GYPSY MOTH NEWS

Northeastern Area

USDA
Forest Service

March 1990
Number 22



Photo courtesy of FS NE-4751

*In Pennsylvania, during the years 1969-1987, the gypsy moth caused an estimated 6 billion cubic feet of tree mortality worth over 200 million dollars.*

***Source:***
*K. Gottschalk, USDA Forest Service*
*J. Quimby, Pennsylvania Bureau of Forestry*

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Gypsy Moth News
USDA Forest Service
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## FROM THE EDITOR

As we approach the Spring of 1990, an estimated 1.1 million acres are scheduled to be sprayed for gypsy moth control in the Northeast and Michigan. An average treatment cost of $15 per acre means that roughly 15 million dollars will be spent by States and the Federal government for this year's treatment. In some ways, this figure reflects the importance that government (and therefore society) places upon controlling this pest. I can think of several reasons for this high degree of importance: 1) The gypsy moth, unlike some other forest pests, is a problem that affects a lot of people. People place a high priority on the trees in their yards, along their streets, and in their parks and greenways. Since the gypsy moth can dramatically alter our urban tree environment, it has become a pest that strikes an important chord in the values of many people. 2) As the statistic on this issue's cover relates, the gypsy moth also threatens an important oak resource in the Northeast. Maybe threatening a resource is a little overdramatic, but the pest does impose serious timber management implications for those who make a living growing and selling oak timber. 3) The final reason is the millions of caterpillars that can invade residential areas during a gypsy moth outbreak. This is one concern we hear over and over again from homeowners. This is the nuisance part of gypsy moth and it is a concern that can rally a neighborhood into action faster than many other neighborhood concerns.

What about the cure? Is the cure worse than the problem? There is no small amount of concern over how we treat this problem. At present, treating a million acres means that pesticides will be aerially sprayed over forests, parks, and forested residential areas. Right in the middle of all this sits State and Federal agencies responsible for making decisions that alleviate the problem while protecting the environment. It is because of these environmental concerns that these same agencies struggle to find the safest and most effective means to control the gypsy moth. These efforts have led to new materials being developed such as the virus Gypchek, or the mating disruption material Disrupt®. These are new attempts to solve the problem while minimizing effects upon the environment.

As we move into the 1990's, and the gypsy moth continues to move west and south, this balancing act between the problem and the cure will grow more evident. And, as it does, our desire to find the perfect balance will also grow.

This issue focuses upon a subject often overlooked by pest management specialists--What to do with the dead trees. And, of all places the gypsy moth seems to have found a home--in Utah!

D. Twardus

## LETTERS TO THE EDITOR

Roy G. Hatcher, Iowa Department of Natural Resources, writes:

> **"I am including a copy of the final report on Iowa's first gypsy moth control project. I thought it might be of interest to your readers to see how a midwestern State copes with its first gypsy moth infestation."**

We have been surveying for gypsy moth in Iowa since 1973 and we are very aware of what the consequences might be if we allow the gypsy moth to get established in Iowa. We had more detections this year than we ever had and are aware that we will be having more infestations show up in our State.

**Location of Treatment Area**: A portion of the Millcrest residential area in southwest Clinton, Iowa.

**Area Treated**: 9 acres.

**Material Used**: *Bacillus thuringiensis* var. *kurstaki* marketed under the Sandoz Crop Protection trade name SAN 415.

**Application Rate**: 64 oz. SAN 415 in 100 gallons of water applied to all host foliage per acre.

**Dates and Number of Applications**: Three (May 16, May 25, and June 6, 1989).

**Kind of Equipment Used**: One John Bean hydraulic sprayer and four hand operated sprayers.

**Discussion**: The effectiveness of the treatment, as indicated by the results of the 1989 trapping sea-

son, indicates the work was successful. High density trapping was conducted in the Millcrest residential area. Traps were inspected at frequent intervals during the prime recovery period and at regular intervals with other traps the remainder of the season. No positive recoveries were made.

Mr. K. Rhody of the Pennsylvania Bureau of Forestry, writes:

> **"Are household cleaning products effective at destroying egg masses?"**

Thomas Odell, a research entomologist with the USDA Forest Service, responds:

> "The use of household cleaning products containing pine oil *may be* effective at killing overwintering (diapausing) larvae in egg masses, but to my knowledge, it has not been tested scientifically. While laboratory testing could quickly evaluate the consequences of painting or spraying household cleaning products on egg masses, it would be more difficult to determine the potential phytotoxicity to plant tissue if it was sprayed or painted on bark. Since most cleaning products have excellent penetrating capabilities they may reach important plant tissues, killing plant cells as well as gypsy moth."
>
> "Another consideration in trying to reduce gypsy moth populations by destroying egg masses is the potential for actually effecting population reduction. There is no evidence that scraping or painting egg masses by hand contributes to reducing the impact of gypsy moth. When you can easily find egg masses to treat, there are just to many out-of-reach or out-of-sight to make your efforts worthwhile (aside from the satisfaction of eliminating a few nasties). In addition, scraping egg masses or spraying or painting them with materials not registered for use against gypsy moth may be dangerous to your health and/or the plant's. Egg masses are covered with fine hairs (setae), deposited around the eggs by their mother. They have known allergenic properties; they should not be handled without gloves, breathing the hairs should be avoided, and eyes should be protected. In short, be forewarned that trying to destroy egg masses, while noble, may be hazardous to plant tissue and you!"

## UTAH GYPSY MOTH PROGRAM

**Steve Munson**
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**Ogden, Utah 84401**

The gypsy moth appeared in Utah in 1988. Following the initial find of five male moths on the University of Utah campus, an intensive delimiting program was initiated in the Salt Lake City area near the Wasatch Mountains. Gypsy moth pheromone traps extended southward to Provo and north to Brigham City. Of the 1,737 traps placed in the field, 114 recorded multiple catches. The final male moth catch in 1988 was 1,292. Over 90 percent of the male moths caught were collected southeast of Salt Lake City. Because populations of the insect were not discovered until late July, delimitation trapping of the adult male moths was not adequate to describe treatment boundaries. Therefore, the treatment program conducted in 1989 was based on the finds of other life stages (egg masses and pupal cases). Many of the male moths captured within the Salt Lake area were thought to be artifacts of the core infestation.

Based on the results of the egg mass survey a 1,200-acre block was designated for treatment in 1989. An area less than 1 acre in size, had egg mass numbers exceeding 4,000 egg masses/acre. Three applications of *Bt* (Dipel 8L at 96 oz./acre, 16 BIU's) were used to suppress the gypsy moth populations within the treatment block. Pre- and post-spray larval and egg mass counts were made to determine spray effectiveness. Seven days following the last application, larval counts indicated a 95 percent reduction in larval numbers. Egg mass counts conducted in the fall of 1989, indicated a 98 percent reduction in egg mass numbers within the 10 sites surveyed. Pre-spray egg mass counts ranged from 0 to 4,240 egg masses per acre; post-spray counts ranged from 0 to 80 egg masses per acre.

Increased public awareness of the gypsy moth in Utah also led to the discovery of two isolated popu-

lations in Bountiful and Provo, Utah. As a result of the late finds, ground applications of Orthene were made on 4th and 5th instar larvae within the affected sites. Milk carton traps were placed within the three treatment areas at densities of 4-8/acre depending on vegetation types present.

Based on the 1989 pheromone trap results, 13 treatment blocks totaling 20,064 acres have been designated for treatment in the 1990 aerial eradication program. The 13 blocks are scattered along the Wasatch Front in Utah, Davis, and Salt Lake Counties. Three applications of *Bt* (24 BIU's) will be applied undiluted at 7-10 day intervals. The first application should begin the first week in May. As a result of the trapping data, the quarantine boundary has also been expanded to encompass 150,000 acres in the 3-county area. Trapping intensity has more than doubled from the 1989 program. Over 11,500 pheromone traps will be used in the detection and delimiting programs in 1990.

Many obstacles have to be overcome to ensure the success of the eradication program. Terrain, weather, and phenological development of both host and insect make this a challenging program. Excellent cooperation between agencies has enabled quick and effective action to deal with the problems this pest presents, not only to Utah but to most of the intermountain west.

## NEW PUBLICATIONS

Dubois, Normand R., Pamela J. Huntley, DeAdra Newman. 1989. Potency of *Bacillus thuringiensis* strains and formulations against gypsy moth and spruce budworm larvae: 1980-86. Gen. Tech. Rep. NE-131. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 25 p.

Two hundred and sixty strains and 70 commercial preparations of *B. thuringiensis* were bioassayed against the gypsy moth and spruce budworm. Toxicity of individual strains differed between the two insects. Standardized commercial preparations produced in 1986 were 200 percent more efficacious than those produced in 1980. Regression coefficients of preparations from one manufacturer were consistent but differed between manufacturers.

Teske, Milton E., Daniel B. Twardus, Robert B. Ekbland. 1990. Swath Width Evaluation. USDA Forest Service, 3400--Forest Pest Management, 90342807-MTDC. 22 p.

Deposition predictions by the computer program AGDISP are used to evaluate swath widths for selected aircraft spraying selected material in the Northeast to combat gypsy moth.

# GUIDELINES FOR DETERMINING THE ECONOMIC FEASIBILITY OF SALVAGING GYPSY MOTH KILLED HARDWOODS

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Article adapted from: LeDoux, C. B. 1990. Determining the Economic Feasibility of Salvaging Gypsy Moth Killed Hardwoods. Forest Products Journal (In Press).

## INTRODUCTION

Since the introduction of the gypsy moth to the United States in 1869, the pest has become established in the northeastern United States from Maine to northern Virginia. Practically all forest stands in the Northeast are susceptible to gypsy moth defoliation. Stands containing oaks of all types, birch and aspen are particularly vulnerable.

Although defoliation is an important measure in predicting the extent of tree mortality in a stand, other factors such as stand and site characteristics and composition, and invasion of types of insects and fungi have an overall influence on tree mortality. The challenge to managers and planners is not only to estimate defoliation and mortality, but to also determine which stands are economical to harvest.

Generally, pulping and lumber recovery studies suggest that pulp and lumber can be recovered from gypsy moth-killed trees, provided the trees were harvested within a period of 1 to 3 years of the trees' death.

Although pulping and recovery studies have been conducted, mortality estimators developed, and silvicultural guidelines to minimize losses documented, a need exists for evaluating which stands will be economical to salvage. A rigorous financial analysis must be conducted using accurate estimates of logging cost for alternative logging technologies. The logging costs need to be integrated with wood value estimates to determine what is economical to salvage and what is not. Accordingly, in this report, a methodology and guidelines are documented providing estimates that can be used to determine which stands are economically feasible to harvest.

## ESTIMATING LOGGING COSTS

Stump-to-mill logging cost estimates were developed for salvaging gypsy moth killed hardwoods for cable and ground-based logging systems. The cost estimates were developed using ECOST and EASTCOST. ECOST and EASTCOST are microcomputer programs that can be used to estimate the stump-to-mill cost of cable and ground-based logging in the mountainous terrain in the Eastern United States. Stand data used were from 574 sample 1/10-acre plots established in Pennsylvania in 1978 before the gypsy moth infestation of the 1980's. Cumulative tree mortality was annually measured from 1979 to 1985 on all plots. Table 1 represents what is potentially possible in salvaging dead hardwood trees. The specific logging technologies evaluated included the Clearwater cable yarder for steep terrain applications and a John Deere 540B skidder for moderate to gentle terrain. Both of these machines are representative of cable and ground-based logging technology. The transportation haul distances evaluated ranged from 20 to 60 miles.

## ESTIMATING WOOD VALUE

Three levels of delivered prices for sawlog and pulpwood/fuelwood by oak species were used--high, medium, and low (Table 2). The range of price levels between the product classes in Table 2 was obtained from Forest Products Price Bulletins. Only sawlog and pulpwood products were evaluated as these are the products most likely to be salvaged from gypsy moth-killed trees. Veneer logs were not treated, since log buyers generally were reluctant to purchase veneer logs from dead standing or downed timber.

Figure 1 shows the relative revenue curves by price level and average cut-tree d.b.h. for red oak and a fixed volume removal of 2,000 cubic feet. The revenue curves rise sharply in the range of 12- to 13-inch average tree d.b.h. This is due to the fact that as trees get larger, more medium and large sawlogs are produced. Larger logs fetch higher price levels.

## ECONOMIC FEASIBILITY

Figure 2 shows the relative revenue differences for red, white, chestnut, scarlet, and black oak. Economic feasibility can be determined by focusing on the intersections of the cost and revenue curves (Figure 1). Each intersection defines the minimum average d.b.h. that is economically feasible for the specified cost and revenue assumptions. These intersections define break-even salvage harvest conditions. Conditions beyond these break-even points represent what is profitable in salvaging gypsy moth killed hardwoods. For example, stands containing trees that average 10-inch d.b.h. can be salvaged using ground-based technology when the haul is 20 miles or less (Figure 1). In contrast, stands must contain trees that average at least 11.5- to 12-inch d.b.h. and be within a short 20-mile haul to be economical when using cable logging technology. Figure 1 is specific to red oak and a fixed volume removal of 2,000 cubic feet.

## SELECTING SALVAGEABLE STANDS

The data and methodology mentioned above were used to develop economic feasibility matrices for red, white, chestnut, scarlet, and black oak (Figures 3 through 9).

The major differences in Figures 3-9 are the interactive effects of logging technology, species, price levels, and haul distances on the economic feasibility of harvesting a particular stand. For example, stands containing primarily red oak trees that average 13 inches d.b.h. (Figure 3), 1,500 $ft^3$ volume removal, using cable logging technology, with 60-mile haul distances, are economically feasible to harvest at high, medium, and low prices. In contrast, similar combinations of logging technology, volume removal, and haul distance for stands consisting of white oak trees (Figure 4), 60-mile hauls are only economical at the high price level. Since the combinations of logging technology and haul distance remain the same, the difference in economic feasibility in this case is due to the difference in prices for red and white oak products.

Another major difference in Figures 3-9 is the impact of the interaction of logging technology and volume harvested on the economic feasibility of harvesting a stand. For example, stands consisting of chestnut oak trees, using cable logging technology (Figure 5) are economical if the trees average at least 12 inches d.b.h., with at least 1,500 $ft^3$ of volume, high price levels, and be within 20 miles to a mill. For similar species, prices, haul combinations, using ground-based technology (Figure 9), stands containing trees that average at least 10 inches d.b.h. and 2,500 $ft^3$ of volume can be harvested if the price level is high and the stand is located within 20 miles of a mill.

Managers, planners, landowners, and loggers can use these matrices to help determine what stands are profitable to salvage. For example: a landowner is looking to salvage a stand with heavy mortality, trees averaging 10 inches d.b.h., volume of 3,000 cubic feet, primarily scarlet oak, on moderate ground. He/she would enter the matrices in Figures 6 and 8, since the stand could be logged with either logging technology. From Figure 6, cable logging this stand simply would not be economical. From Figure 8, ground-based logging this stand would be economically feasible if the haul distance to the mill was less than or equal to 20 miles and only at high-price levels. Other evaluations would follow similar logic.

The methodology described here could be linked to inventory or stand data bases to determine which stands have salvage potential and also to develop salvage guidelines. The focus on management then could be restricted to those stands offering the most potential. In practice, this analysis could be repeated as often as necessary to include changes in product markets, prices, harvesting technology, or silvicultural objectives.

## CONSIDERATIONS FOR MANAGERS

Logging costs decreased with increasing average cut-tree d.b.h.

The most profitable stands will be those with high volumes, valuable species mix, have trees with grade logs, on gentle ground, salvageable by ground-based systems, and close hauls to the mill.

The trees should be salvaged, if possible, before they die; but if they were dead, they should be salvaged within 1 year to minimize pulpwood and lumber recovery losses.

Submarginal salvage efforts may be packaged with more profitable stands into one economical harvest. In stands with low volumes of dead material, thinning of live trees can be used to increase the volume and value of the logging operation to make it more profitable. Methods such as those summarized here can be linked to existing inventory data bases to evaluate candidate stands for salvage operations.

Although these guidelines include only two types of logging technology, three levels of market price, and transport mileage, one can easily evaluate other scenarios with the methodology presented by simply making additional simulation runs.

For more information, contact Dr. Chris LeDoux, USDA Forest Service.

## LITERATURE REVIEWED


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LeDoux, C. B. 1985. Stump-to-mill timber production cost equations for cable logging eastern hardwoods. Research Paper NE-566. Broomall, PA. USDA Forest Service, Northeastern Forest Experiment Station: 6 p.

LeDoux, C. B. 1988. EASTCOST--stump-to-mill timber production cost equations and computer program. Unpublished report on file at USDA Forest Service, Northeastern Forest Experiment Station, 180 Canfield St., Morgantown, WV 26505.

Table 1.--Summary of Sample Oak Plots (N=574) characteristics.[1]

| Item | Average | Minimum | Maximum |
|---|---|---|---|
| D.b.h. (in) | 9.33 | 5.70 | 15.97 |
| Butt log grade | 3.71 | 2.17 | 4.00 |
| Cubic foot[2] volume | 1524.62 | 35.00 | 5134.00 |
| Board foot[3] volume | 4939.87 | 140.00 | 25154.00 |
| Age (yr) | 71.14 | 17.00 | 177.00 |
| Slope (%) | 24.00 | 0.00 | 67.00 |
| Merchantable height (ft) | 30.39 | 8.00 | 52.89 |
| No. Trees | 154.00 | 30.00 | 360.00 |

[1] All units are per acre.
[2] Smalian's method.
[3] International 1/4 scale.

Table 2.--High, medium, and low price levels by species and product type.

(Dollars per thousand board feet)
(International 1/4 scale)

| Species | Large Sawlogs[1] | Medium Sawlogs[2] | Small Sawlogs[3] | Pulpwood Fuelwood[4] |
|---|---|---|---|---|
| Northern Red Oak | 300 | 250 | 125 | 40 |
| | 275 | 225 | 100 | 30 |
| | 250 | 200 | 80 | 20 |
| White Oak | 255 | 225 | 125 | 40 |
| | 220 | 170 | 100 | 30 |
| | 200 | 150 | 80 | 20 |
| Chestnut Oak | 235 | 185 | 125 | 40 |
| | 210 | 160 | 100 | 30 |
| | 190 | 140 | 80 | 20 |
| Scarlet/black oak | 135 | 115 | 95 | 40 |
| | 110 | 90 | 70 | 30 |
| | 90 | 70 | 50 | 20 |

[1] Minimum small end diameter $\geq$ 13 inches, length $\geq$ 10 feet.
[2] Minimum small end diameter $\geq$ 11 inches, length $\geq$ 8 feet.
[3] Minimum small end diameter > 10 inches, length $\geq$ 8 feet.
[4] $/cord, 89 $ft^3$/cord, minimum small end diameter $\geq$ 4.0 inches that will not make large, medium, or small sawlogs.

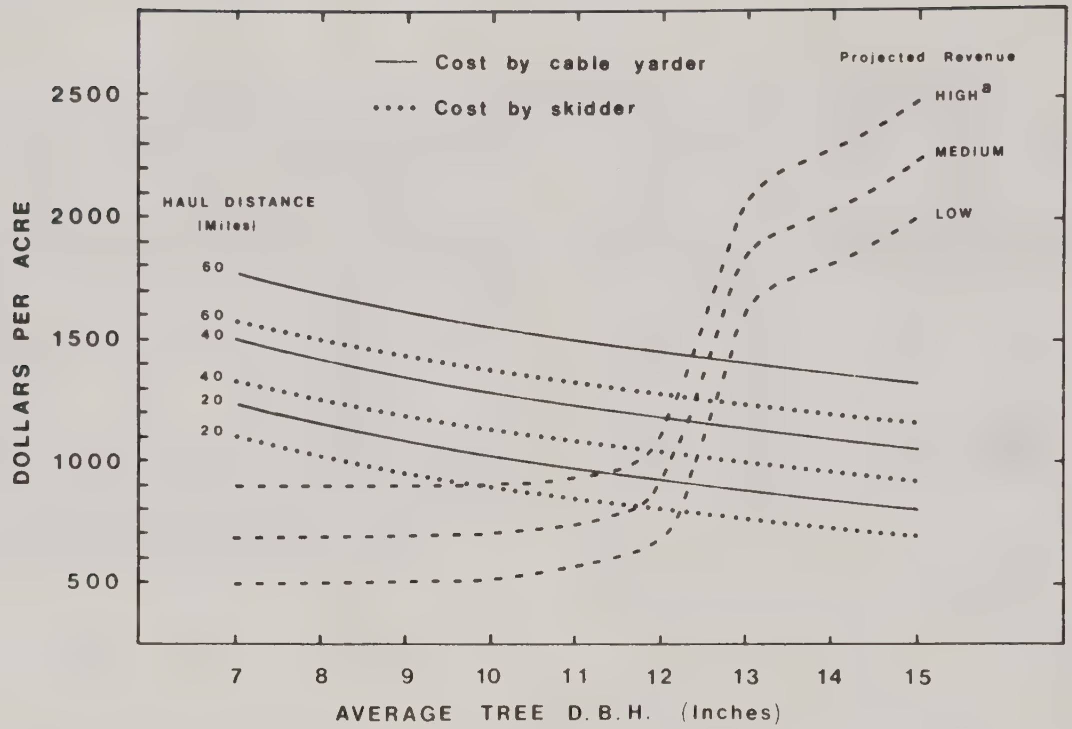


Figure 1.—Simulated cost and revenue per acre by average tree d.b.h., haul distance, and price levels for red oak, volume removal of 2,000 cubic feet. Economic feasibility is shown at the intersection of the cost and revenue curves. Each intersection defines the minimum average d.b.h. feasible for the specified cost and revenue assumptions.

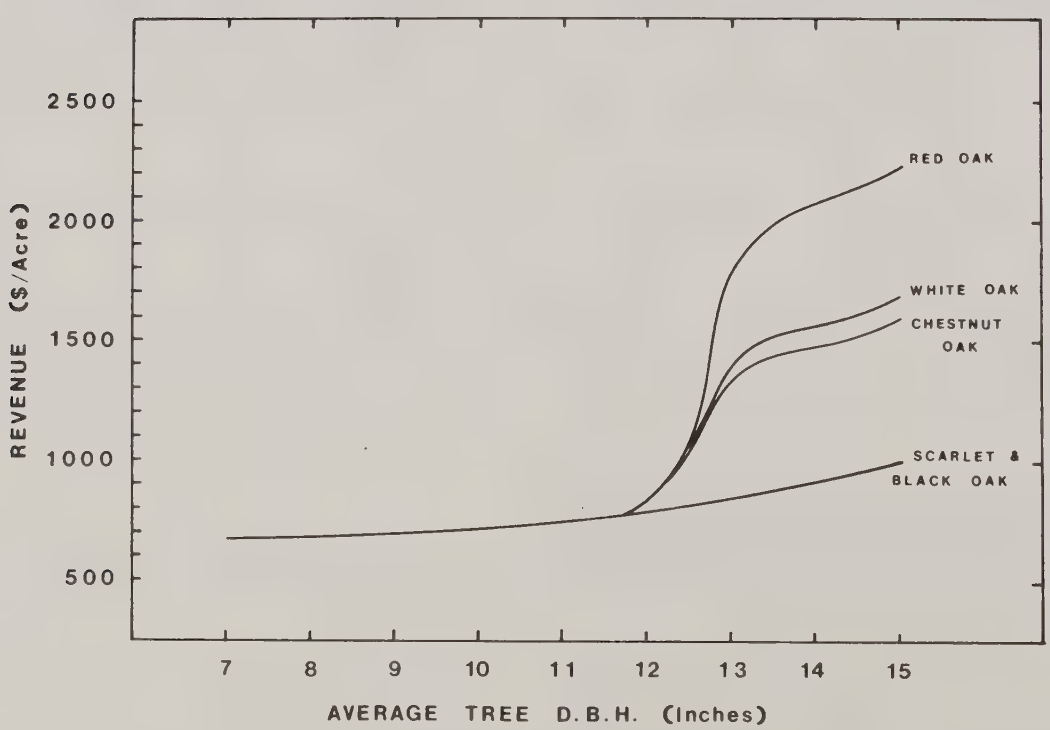


Figure 2.—Simulated revenue per acre by average tree d.b.h. and oak species; assumed volume removal of 2,000 cubic feet, price level is medium.

## Price Levels For Economic Salvage Operations—Cable Logging

| VOLUME SALVAGED -Ft$^3$/Acre- | HAUL DISTANCE -Miles- | AVERAGE D. B. H. (Inches) 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1500 | 20 | N | N | N | N | N | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M L | H M L | H M L |
| 2000 | 20 | N | N | N | N | N | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M L | H M L | H M L |
| 2500 | 20 | N | N | N | N | N | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M L | H M L | H M L |
| 3000 | 20 | N | N | N | N | N | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M L | H M L | H M L |

Figure 3.—Red oak.

| VOLUME SALVAGED -Ft$^3$/Acre- | HAUL DISTANCE -Miles- | AVERAGE D. B. H. (Inches) 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1500 | 20 | N | N | N | N | N | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H | H M | H M L |
| 2000 | 20 | N | N | N | N | N | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M | H M | H M L |
| 2500 | 20 | N | N | N | N | N | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M | H M | H M L |
| 3000 | 20 | N | N | N | N | N | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M | H M | H M L |

Figure 4.—White oak.

*NOTE:* H = high prices; M = medium prices; L = low prices; and N = not economical at high prices.

| VOLUME SALVAGED -Ft³/Acre- | HAUL DISTANCE -Miles- | AVERAGE D.B.H. (Inches) 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1500 | 20 | N | N | N | N | N | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H | H M | H M L |
| 2000 | 20 | N | N | N | N | N | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H | H M | H M L |
| 2500 | 20 | N | N | N | N | N | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H | H M | H M L |
| 3000 | 20 | N | N | N | N | N | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H | H M | H M L |

Figure 5.—Chestnut oak.

| VOLUME SALVAGED -Ft³/Acre- | HAUL DISTANCE -Miles- | AVERAGE D.B.H. (Inches) 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1500 | 20 | N | N | N | N | N | N | H | H | H M |
| | 40 | N | N | N | N | N | N | N | N | H |
| | 60 | N | N | N | N | N | N | N | N | H |
| 2000 | 20 | N | N | N | N | N | N | H | H | H M |
| | 40 | N | N | N | N | N | N | N | N | H |
| | 60 | N | N | N | N | N | N | N | N | H |
| 2500 | 20 | N | N | N | N | N | N | H | H | H M |
| | 40 | N | N | N | N | N | N | N | N | H |
| | 60 | N | N | N | N | N | N | N | N | H |
| 3000 | 20 | N | N | N | N | N | N | H | H | H M |
| | 40 | N | N | N | N | N | N | N | N | H |
| | 60 | N | N | N | N | N | N | N | N | H |

Figure 6.—Scarlet and black oak.

*NOTE:* H = high prices; M = medium prices; L = low prices; and N = not economical at high prices.

## Price Levels For Economic Salvage Operations—Ground-based

| VOLUME SALVAGED -Ft³/Acre- | HAUL DISTANCE -Miles- | AVERAGE D. B. H. (Inches) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 1500 | 20 | N | N | N | N | H | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M L | H M L | H M L |
| 2000 | 20 | N | N | N | N | H | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M L | H M L | H M L |
| 2500 | 20 | N | N | N | H | H | H M | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M L | H M L | H M L |
| 3000 | 20 | N | N | N | H | H | H M | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M L | H M L | H M L |

Figure 7.—Red and white oak.

| VOLUME SALVAGED -Ft³/Acre- | HAUL DISTANCE -Miles- | AVERAGE D. B. H. (Inches) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 1500 | 20 | N | N | N | N | H | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M L | H M L | H M L |
| 2000 | 20 | N | N | N | N | H | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M L | H M L | H M L |
| 2500 | 20 | N | N | N | N | H | H M | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M L | H M L | H M L |
| 3000 | 20 | N | N | N | H | H | H M | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M L | H M L | H M L |

Figure 8.—Scarlet and black oak.

*NOTE:* H = high prices; M = medium prices; L = low prices; and N = not economical at high prices.

| VOLUME SALVAGED -Ft³/Acre- | HAUL DISTANCE -Miles- | AVERAGE D. B. H. (Inches) 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1500 | 20 | N | N | N | N | H | H | H M | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M | H M L | H M L |
| 2000 | 20 | N | N | N | N | H | H | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M | H M L | H M L |
| 2500 | 20 | N | N | N | H | H | H M | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M | H M L | H M L |
| 3000 | 20 | N | N | N | H | H | H M | H M L | H M L | H M L |
| | 40 | N | N | N | N | N | N | H M L | H M L | H M L |
| | 60 | N | N | N | N | N | N | H M L | H M L | H M L |

Figure 9.—Chestnut oak.

*NOTE:* H = high prices; M = medium prices; L = low prices; and N = not economical at high prices.